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मानक

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“Step Out From the Old to the New”

IS 13778-6 (2011): Winding Wires - Test Methods, Part 6:
Thermal properties [ETD 33: Winding Wire]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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IS 13778 (Part 6) : 2011
IEC 60851-6 : 1996

भारतीय मानक
वेष्टन — परीक्षण पद्धतियाँ
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(पहला पुनरीक्षण)

Indian Standard
WINDING WIRES — TEST METHODS
PART 6 THERMAL PROPERTIES
(*First Revision*)

ICS 29.060.10

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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NATIONAL FOREWORD

This Indian Standard (Part 6) (First Revision) which is identical with IEC 60851-6 : 1996 'Winding wires — Test methods — Part 6: Thermal properties' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Winding Wires Sectional Committee and approval of the Electrotechnical Division Council.

This standard was originally published in 1993. This revision has been undertaken with a view to bring it in line with the latest version of IEC 60851-6.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60172 : 1987 Test procedure for the determination of the temperature index of enamelled winding wires	IS 5825 : 1993 Test procedure for the determination of the temperature index of enamelled winding wires (<i>first revision</i>)	Identical
IEC 60851-1 : 1996 Winding wires — Test methods — Part 1: General	IS 13778 (Part 1) : 2011 Winding wires — Test methods: Part 1 General (<i>first revision</i>)	do
IEC 60851-3 : 1996 Winding wires — Test methods — Part 3: Mechanical properties	IS 13778 (Part 3) : 1993 Methods of test for winding wires: Part 3 Mechanical properties	Technically Equivalent
IEC 60851-5 : 1996 Winding wires — Test methods — Part 5: Electrical properties	IS 13778 (Part 5) : 1993 Methods of test for winding wires: Part 5 Electrical properties	do

Amendment No. 1 and 2 to the above International Standard has been given at the end of this publication.

Only English language text has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the IEC publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard
WINDING WIRES — TEST METHODS
PART 6 THERMAL PROPERTIES
(First Revision)

1 Scope

This part of IEC 851 specifies the following tests:

- Test 9: Heat shock;
- Test 10: Cut-through;
- Test 15: Temperature index;
- Test 12: Loss of mass.

For definitions, general notes on methods of test and the complete series of methods of test for winding wires see IEC 851-1.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 851. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 851 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of the IEC and ISO maintain registers of currently valid International Standards.

IEC 172: 1987, *Test procedure for the determination of the temperature index of enamelled winding wires*

IEC 851-1: 1996, *Winding wires – Test methods – Part 1: General*

IEC 851-3: 1996, *Winding wires – Test methods – Part 3: Mechanical properties*

IEC 851-5: 1996, *Winding wires – Test methods – Part 5: Electrical properties*

3 Test 9: Heat shock (applicable to enamelled and tape wrapped wire)

Heat shock is the potential of the wire to withstand temperature exposure after the wire has been stretched and/or wound or bent around a mandrel.

3.1 Specimen

3.1.1 Round wire

A specimen shall be prepared in accordance with:

- 5.1.1 of IEC 851-3 for enamelled wires with a nominal conductor diameter up to and including 1,600 mm;

- 5.2 of IEC 851-3 for enamelled wires with a nominal conductor diameter over 1,600 mm;
- 5.1.1 of IEC 851-3 for tape wrapped wires with a nominal conductor diameter up to and including 1,600 mm;
- 5.5.4 of IEC 851-3 for tape wrapped wires with a nominal conductor diameter over 1,600 mm.

3.1.2 Rectangular wire

A specimen shall be prepared in accordance with 5.1.2 of IEC 851-3, bent however, only flatwise (on the thickness).

3.2 Procedure

The specimen is placed into an oven with forced air circulation for a period of 30 min and at a temperature ± 5 °C specified in the relevant standard. After removal from the oven, the specimen shall be allowed to cool to room temperature and shall then be examined for cracks under a magnification according to table 1.

Table 1 – Magnification

Wire dimension	Magnification
Round wire of nominal conductor diameter up to and including 0,040 mm	10 to 15 times
Round wire of nominal conductor diameter over 0,040 mm up to and including 0,500 mm	6 to 10 times
Round wire of nominal conductor diameter over 0,500 mm	0 to 6 times
Rectangular wire	6 to 10 times

3.3 Result

Three specimens shall be tested in the case of round wire and two specimens shall be tested in the case of rectangular wire. Any crack detected shall be reported.

4 Test 10: Cut-through (applicable to enamelled round wire with a nominal conductor diameter over 0,100 mm up to and including 1,600 mm and tape wrapped round wire)

Cut-through is expressed as the temperature at which a short circuit occurs between two pieces of wire crossing each other at right angles with a specified load applied to the crossing point.

NOTE – In many cases, the cut-through temperature indicates decomposition of the insulation.

4.1 Equipment

The following equipment shall be used:

- metal block of brass or aluminium provided with means for electrical heating and temperature measurement and control, with two slots for inserting two wire pieces, which cross each other at right angles with the crossing point in the centre of the block, and with a ceramic piston to apply a load on the crossing point, as shown in figure 1;
- transformer of at least 100 VA providing an alternating test voltage of (100 ± 10) V, connected to an overcurrent device operating at a current of (5 ± 1) mA, and to a resistor limiting the current to 50 mA maximum.

4.2 Procedure

Two straight pieces of wire shall be inserted into the metal block crossing each other at right angles, with the metal block pre-heated at the temperature specified in the relevant standard. The temperature shall be measured as close as possible to the crossing point and shall not vary by more than ± 3 °C from the specified value. The crossing point shall lie centrally under the piston. In the case of wire of a nominal conductor diameter of less than 0,200 mm, two straight pieces of wire shall be placed in parallel, side by side, and a third piece shall be placed at right angles across the first two with the crossing points arranged symmetrically to the axis of the piston.

After a heating period as given in table 2, a load as given in table 3 shall be applied by means of the piston. Immediately thereafter, the test voltage shall be applied between the lower and upper pieces of wire. In the case where two lower pieces are used, they shall be connected. The load and the test voltage shall be applied for 2 min.

Three tests shall be made. Any failure shall be reported.

Table 2 – Heating period

Nominal conductor diameter mm		Time from inserting until loading min
Over	Up to and including	
–	1,000	1
1,000	1,600	2

Table 3 – Loads applied to the crossing point

Nominal conductor diameter mm		Load
Over	Up to and including	N
0,100	0,125	1,25
0,125	0,315	2,20
0,315	0,500	4,50
0,500	0,800	9,00
0,800	1,250	18,00
1,250	1,600	36,00

5 Test 15: Temperature index

5.1 Enamelled wire

5.1.1 Round wire

The temperature index shall be determined in accordance with IEC 172.

5.1.2 Rectangular wire

As IEC 172 makes no provision for testing rectangular wire, the test shall be made on round wire with a nominal conductor diameter preferably of 1,000 mm and of grade 2, using coating of the same formulation as that applied to the rectangular wire, unless otherwise agreed between purchaser and supplier.

5.2 Tape wrapped wire

Method of test under consideration.

6 Test 21: Loss of mass (applicable to enamelled round wire)

Loss of mass refers to the wire coating and indicates the degree of curing.

6.1 Specimen

A piece of wire providing not less than 0,5 g of coating shall be cleaned by adequate means without affecting the coating. The specimen shall be heated for 1 h at $(130 \pm 3) ^\circ\text{C}$ in an oven with forced air circulation. After removal from the oven, the specimen shall be placed in a desiccator and allowed to cool to room temperature for at least 30 min. The specimen shall then be weighed to 0,1 mg (M_1).

6.2 Procedure

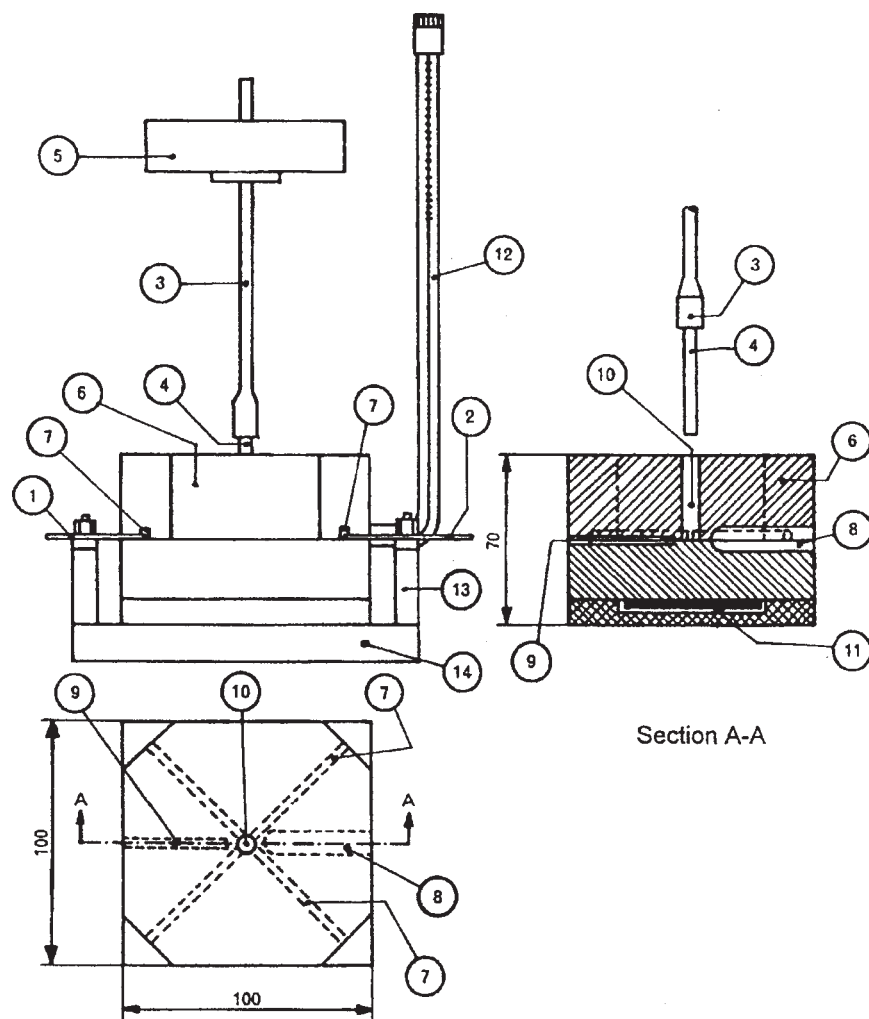
A crucible shall be conditioned for 2 h at $(150 \pm 3) ^\circ\text{C}$. The crucible containing the specimen shall then be placed in an oven with forced air circulation for 2 h at a temperature that varies by not more than $\pm 3 ^\circ\text{C}$ from the value specified in the relevant standard. After removal from the oven, the specimen shall be placed in a desiccator and allowed to cool to room temperature for at least 30 min. The specimen shall then be weighed to 0,1 mg (M_2).

The coating shall be removed by suitable chemical means not affecting the conductor, and the bare conductor shall be dried for (15 ± 1) min at $(150 \pm 3) ^\circ\text{C}$, placed in a desiccator and allowed to cool to room temperature for at least 30 min. The bare conductor shall then be weighed to 0,1 mg (M_3).

The loss of mass shall be determined according to the following equation:

$$\Delta M = \frac{M_1 - M_2}{M_1 - M_3} \times 100 \%$$

Two tests shall be made. The two single values shall be reported.



- | | |
|--|---|
| 1 = specimen | 8 = hole for insertion of the temperature controlling device |
| 2 = specimen | 9 = hole for insertion of the thermocouple |
| 3 = piston | 10 = hole for insertion of the loaded piston |
| 4 = ceramic piston | 11 = electrical heating element |
| 5 = load | 12 = temperature controlling device |
| 6 = metal block (copper or brass) | 13 = insulated terminals for connection of the wire specimens |
| 7 = slots for insertion of the specimens | 14 = insulated base plate |

Dimensions in millimetres

Figure 1 – Compression device for the cut-through test

Annex A (informative)

High temperature failure test (applicable to enamelled round wire)

High-temperature failure is expressed by the time to failure of a specimen, which is connected to a test voltage while exposed to elevated temperature.

NOTE – This test is intended to indicate the performance of wire at temperatures up to 450 °C where overload conditions under voltage stress may be encountered. It is not possible to use this test for conditions which produce failures in seconds or in a few minutes because this test requires a minimum time-to-failure of 15 min. Where such short-time failure properties are needed, other tests are required.

A.1 Equipment

The following equipment is used:

- oven with or without forced air circulation providing a maximum service temperature of 450 °C. The temperature should not vary from the set temperature by more than ± 5 °C. The design of the oven ensures that the specimen reaches the set temperature ± 1 % within 3 min. The oven is equipped with appropriate terminals to apply the test voltage in accordance with table A.1.
- transformer of at least 100 VA providing an alternating test voltage of 50 Hz or 60 Hz according to table A.1, connected to an overcurrent device operating at a current of (10 ± 5) mA. To avoid over-voltage surges, a capacitor of 1 μ F to 2 μ F is connected in parallel with the secondary terminals of the transformer. The overcurrent device indicates failure and disconnects a corresponding timer.

Table A.1 – Test voltage

Increase in diameter due to the insulation mm		Test voltage (a.c.) V
Over	Up to and including	
0,024	0,035	65
0,035	0,050	85
0,050	0,070	115
0,070	0,090	165
0,090	0,130	200

A.2 Specimen

A specimen is prepared in accordance with 4.4 of IEC 851-5. Experience has shown that wire with a nominal conductor diameter of about 1 mm and of grade 2 has been found convenient to handle and to test.

A.3 Procedure

The specimen is connected to the terminals and placed in the oven preheated to the temperature selected for the test. The test voltage is immediately applied and the timer started.

Five specimens are tested. The times to failure are reported. A time to failure below 15 min is disregarded.

AMENDMENT NO. 1

Page 15

Replace the existing clause 5 by the following:

5 Test 15: Temperature index

5.1 Enamelled wire

5.1.1 Round wire

The temperature index shall be determined in accordance with IEC 60172 (on unimpregnated specimens).

5.1.2 Rectangular wire

As IEC 60172 makes no provision for testing rectangular wire, the test shall be made on round wire in accordance with 5.1.1, using a coating of the same formulation as that applied to the rectangular wire.

5.2 Tape wrapped wire

Under consideration.

AMENDMENT NO. 2

Throughout the text, add 60000 to the numbers of the standards cited. For example, change «IEC 851» to «IEC 60851».

Page 7

INTRODUCTION

Replace the existing text with the following:

This standard is one of a series which deals with insulated wires used for windings in electrical equipment. The series comprises three groups:

- 1) winding wires – Test methods (IEC 60851);
- 2) specifications for particular types of winding wires (IEC 60317);
- 3) packaging of winding wires (IEC 60264).

Page 11

Table 1

In the last column, 4th row, replace "0 to 6 times" with "1 to 6 times".

Page 13

4.1 Equipment

Replace, in the second line, "metal block of brass or aluminum" by "metal block of brass or copper".

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Amendments Issued Since Publication

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